The opinion in support of the decision being entered today
is *not* binding precedent of the Board.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Ex parte TERRY L. GILTON

Appeal 2007-2146
Application 09/177,814
Technology Center 1600

Decided: July 16, 2007

Before DONALD E. ADAMS, ERIC GRIMES, and NANCY J. LINCK, *Administrative Patent Judges*.

GRIMES, *Administrative Patent Judge*.

DECISION ON APPEAL

This is an appeal under 35 U.S.C. § 134 involving claims to a miniaturized separation apparatus, which the Examiner has rejected as anticipated and obvious. We have jurisdiction under 35 U.S.C. § 6(b). We reverse the rejection for anticipation but affirm the rejections for obviousness.

BACKGROUND

"Various techniques have long been employed to separate the constituents of a sample" (Specification 2), including various forms of chromatography (*id.* at 2-6) and electrophoresis (*id.* at 6). The Specification discloses a "sample separation apparatus . . . [that] includes a substrate with a capillary column thereon, the latter comprising a rough surface, such as a matrix which defines a plurality of pores therethrough" (*id.* at 7). "Preferably, the capillary column . . . comprises porous silicon or hemispherical grain silicon, and is formed on a silicon substrate" (*id.*).

The apparatus can be used as a chromatography column (*id.*) or, if it includes oppositely charged electrodes, can be used for electrophoresis (*id.* at 8). Electrodes (anode and cathode), as well detectors, valves, etc. "may be fabricated upon the substrate in a desired location by known semiconductor fabrication processes" (*id.* at 19).

DISCUSSION

1. CLAIMS

Claims 1, 3-11, 13-29, 111, and 112 are pending and on appeal. With respect to the obviousness rejections, the claims have not been argued separately and therefore stand or fall together. 37 C.F.R. § 41.37(c)(1)(vii). We will focus on claims 1 and 21, which read as follows:

> 1. A sample separation apparatus, comprising:
>
> a substantially solid substrate;
>
> matrices formed in said substrate, the matrices comprising at least two distinct, unconnected porous regions comprising the same material as the substrate, each of the at least two porous regions extending at least partially across the substrate; and

at least one detector fabricated on the substrate in communication with at least one of the at least two porous regions.

21. The sample separation apparatus of claim [1, further comprising a migration facilitator in communication with at least one of the at least two porous regions], wherein the migration facilitator comprises a vacuum source operatively in communication with a second end of the at least one porous region.

Claim 1 is directed to an apparatus that comprises a substrate and has at least two unconnected porous regions that comprise the same material as the substrate and a detector fabricated on the substrate and in communication with at least one of the porous regions. Claim 1 also requires that the porous regions "extend[ ] at least partially across the substrate." The Specification does not expressly define this limitation. The USPTO gives claims their broadest reasonable interpretation that is consistent with the Specification. Since the Specification provides no limiting definition of the phrase, we interpret "extending at least partially across the substrate" to mean that the porous regions extend at least some distance – any distance – across the length, width, or depth of the substrate.

Claim 21 adds the limitation that the apparatus includes a vacuum source that facilitates migration of sample through one of the porous regions.

2. PRIOR ART

The Examiner relies on the following references:

Knoll	US 5,393,401	Feb. 28,1995
Heller	US 5,605,662	Feb. 25, 1997
Vickers	US 5,693,946	Dec. 2, 1997
Northrup	US 5,882,496	Mar. 16, 1999
Dubrow	US 5,948,227	Sep. 7, 1999
Burns	US 6,379,929 B1	Apr. 30, 2002

3. ANTICIPATION

Claims 1, 3, 4, 7, 11, 18, 22-24, 111, and 112 stand rejected under 35 U.S.C. § 102(e) as anticipated by Northrup. The Examiner finds that Northrup teaches a device having all of the features recited in claim 1 (Answer 3). Appellant argues that Northrup's device does not include a detector fabricated on a substrate and in communication with one of the porous regions, as required by claim 1 (Br. 11). According to the Examiner, this limitation is met because Northrup "teach[es] that the porous silicon members define an interface between two analysis devices (detectors) (claim 10 [sic, 11?]). Therefore, the porous silicon members would be in communication with the analysis devices, which are considered to be detectors." (Answer 11.)

We will reverse this rejection. Anticipation requires the disclosure, expressly or inherently, of all the limitations of a claimed invention in a prior art reference. *Verdegaal Bros. v. Union Oil Co.*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987) ("A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.").

Here, the Examiner has not explained how Northrup's device can be found to include a detector *fabricated on the substrate* that includes the porous region. At best, the Examiner has established that Northrup describes an apparatus comprising a silicon substrate having porous regions, combined with separate detectors (analysis devices). Such a device does not meet all the limitations of claim 1 and therefore does not anticipate the instant claims.

4. OBVIOUSNESS BASED ON KNOLL AND NORTHRUP

Claims 1, 5, 7, 8, 10, 11, 14, 25-29, 111, and 112 stand rejected under 35 U.S.C. § 103 as obvious in view of Knoll and Northrup. The Examiner cites Knoll's disclosure of "a silicon substrate . . . with ion selective field effect transistors . . . and ion-selective membranes (porous regions) formed in containments on the silicon substrate" (Answer 5). The Examiner cites Northrup's teaching of porous silicon membranes and concludes that

> it would have been obvious to one of ordinary skill in the art for the ion selective membranes of Knoll to be comprised of porous silicon, as suggested by No[r]thrup et al, in order to increase the surface area of a silicon device for use in specific pore size arrays and biological/chemical filters.

(*Id.*)

We agree with the Examiner that Knoll and Northrup support a prima facie case of obviousness. Knoll teaches an apparatus containing a silicon substrate that has a tapered opening (or containment) etched through it (Knoll, col. 2, ll. 38-42, 60-62). The containment is then filled with a liquid to form an ion-selective membrane (*id.* at col. 2, ll. 42-44). Knoll states that

> [t]he manufacture of ion-selective liquid membranes is also known in itself. Such membranes consist for example of a polyvinyl-chloride matrix that includes both a softener and an ionophore, an electrically active substance that dictates the membrane's ion selectivity. The material is dissolved and poured, and the solvent evaporates, leaving a solidified membrane.

(*Id.* at col. 1, ll. 37-43.) Knoll also states that contact between the membrane and the chip's other components can be established by, among other methods, an ion-selective field-effect transistor (ISFET) (*id.* at col. 4, ll. 7-10, 17-18).

Northrup teaches methods of making porous silicon membranes in a crystalline silicon substrate (Northrup, col. 3, ll. 30-60). Northrup also teaches that "the high surface area pores of porous silicon could be coated with specific coatings for the adsorption/desorption of liquids or gases, thereby creating a chemical species concentrator" (*id.* at col. 1, ll. 49-52; *see also* col. 2, ll. 42-45).

We agree with the Examiner that it would have been obvious to a person of ordinary skill in the art to modify Knoll's apparatus by replacing the liquid ion-selective membrane with a porous silicon membrane coated appropriately to cause it to act as an ion-specific membrane. Such a modification is suggested by Northrup's disclosure that porous silicon allows the creation of very small pores with high uniformity and control (Northrup, col. 2, ll. 31-33) and Knoll's disclosure that liquid ion-selective membranes can adhere poorly to the substrate (Knoll, col. 1, ll. 47-50).

Appellant argues that

> neither Knoll nor Northrup teaches or suggests a sample separation apparatus that includes "at least one detector fabricated on [a] substrate in communication with at least one of . . . at least two porous regions," as recited in independent claim 1.

(Br. 15.)

This argument is not persuasive. Knoll teaches ion-selective field-effect transistors (ISFETs) as one means of providing contact between the membrane and other components of the chip (Knoll, col. 4, ll. 7-10). The detector recited in claim 1 includes "field effect transistors (FETs)" (Specification 12). Thus, Knoll teaches a detector in communication with the membrane.

Appellant also argues that, while Knoll's transistors are "associated with each containment 2 . . . , the containments 2 are small, discrete structures which do not extend across the substrate 1 in which they are formed. . . . Thus, the transistors of Knoll do not communicate with a porous region that 'extend[s] at least partially across the substrate [1]'" (Br. 15, bracketed material in original).

This argument is also unpersuasive. As discussed above, we interpret the claim limitation "extending at least partially across the substrate" to require only that the porous region extend some distance – any distance – across any of the three dimensions of the substrate. Since the porous regions are themselves three-dimensional, they necessarily extend "at least partially" across each of the three dimensions of the substrate, and therefore meet this claim limitation.

5. OBVIOUSNESS BASED ON HELLER, VICKERS, AND NORTHRUP

Claims 1, 2, 5-11, 14, 15, 18, 22-24, 111, and 112 stand rejected under 35 U.S.C. § 103 as obvious in view of Heller, Vickers, and Northrup.

The Examiner finds that Heller teaches "a device comprising a silicon wafer (column 12, lines 46-52) having a matrix of addressable microscopic locations on its surface," where each of the micro-locations comprises porous permeation and attachment layers (Answer 6). The Examiner also finds that Heller's device can include "CCD detectors" (*id.*) and cites Vickers as evidence that CCD detectors comprise field-effect transistors (FETs) (*id.*).

The Examiner concedes that the porous layers in Heller's device do not "comprise the same material as the substrate, silicon" (*id.*) but cites

Northrup's disclosure of porous silicon membranes (*id.* at 7) to make up for this deficiency. The Examiner concludes that it would have been obvious to a person of ordinary skill in the art to make the porous layers in Heller's device from the porous silicon taught by Northrup to take advantage of the characteristics disclosed by Northrup: specific pore size arrays suitable for biological/chemical filters with the capability of being doped or coated using conventional techniques (*id.*).

We agree with the Examiner that the cited references would have suggested the apparatus of claim 1. Heller's device comprises discrete microlocations (Heller, Fig. 1), each of which comprises, among other things, a "permeation layer" (*id.*, Fig. 2). "The permeation layer provides spacing between the metal surface and the attachment/binding entity layers and allows solvent molecules, small counter-ions, and gases to freely pass to and from the metal surface" (*id.*, col. 10, l. 65 to col. 11, l. 2). In other words, the permeation layer is porous.

Heller also teaches that the device "facilitates the detection of hybridized complexes at each micro-location by using an associated optical (fluorescent or spectrophotometric) imaging detector system or an integrated sensing component" (*id.*, col. 5, ll. 61-64). The "associated imaging detector element" can be, e.g., a CCD detector (*id.* at col. 20, ll.40-46). Appellant does not dispute that CCD detectors comprise field-effect transistors.

Thus, Heller's device differs from claim 1 only in that the porous regions (i.e., the permeation layer at each micro-location) is not made of silicon, like the substrate (Heller, col. 12, ll. 49-51). However, Northrup teaches methods of making porous silicon membranes in a crystalline silicon

substrate, and teaches that porous silicon membranes "provide specific pore size arrays" suitable for use as, among other things, "chemical/biological filters" (Northrup, col. 1, ll. 30-33, 52-53). We agree with the Examiner that a person of ordinary skill in the art would have found it obvious, based on the cited references to incorporate Northrup's porous silicon membrane as the permeation layer in Heller's device.

Appellant argues that

> [a]lthough Heller discloses that optoelectronic or micro-electronic detection elements may be associated with each of the discrete micro-locations of th[e] device . . . , Heller does not teach or suggest that these detectors communicate with a porous region that "extend[s] at least partially across the substrate" in which the micro-locations have been fabricated.

(Br. 17.)

This argument is unpersuasive for the reason discussed above in relation to Knoll: any three-dimensional feature of a substrate, including the micro-locations of Heller's apparatus, extends "at least partially" across each of the three dimensions of the substrate, and therefore meets this claim limitation.

6. OBVIOUSNESS BASED ON BURNS AND NORTHRUP

Claims 1, 3-5, 7-9, 13, 16-20, 22-27, 111, and 112 stand rejected under 35 U.S.C. § 103 as obvious in view of Burns and Northrup. The Examiner finds that Burns teaches a device having "porous columns of micromachined channels for gel electrophoresis . . . etched on silicon chips . . . as well as temperature sensors [i.e., detectors]" (Answer 8). The Examiner concedes that Burns does not teach "that the porous columns are comprised of the same material as the silicon chip" (*id.*) but cites Northrup's

disclosure of porous silicon membranes (*id.*) and concludes that it would have been obvious to a person of ordinary skill in the art to make the porous columns in Burns' device from the porous silicon taught by Northrup to take advantage of the characteristics disclosed by Northrup: specific pore size arrays suitable for biological/chemical filters with the capability of being doped or coated using conventional techniques (*id.* at 9).

We agree with the Examiner that the cited references would have suggested a device meeting the limitations of claim 1. Burns discloses a chip-based device for amplifying and analyzing DNA (Burns, col. 1, ll. 15-21). The chip is preferably silicon (*id.* at col. 3, ll. 62-63). "[N]ucleic acid separation and analytical components may be used as part of the devices. . . . Gel electrophoresis channels . . . may thus be etched into the substrate" (*id.* at col. 9, ll. 13-25). The chip can also include "a nucleic acid detection means operably connected to, or in electrical communication with, the nucleic acid analysis component" (*id.* at col. 9, ll. 35-37). The detection means can be a "diode detection device with suitable filters for detection of radioactive decay, fluorescence," etc. (*id.* at col. 9, ll. 39-43).

Northrup discloses that a "doped porous silicon membrane with appropriate pore diameter . . . could contain electrodes or arrays of electrodes to control the flow of electrically charged chemicals through the pores (such as in electrophoresis)" (Northrup, col. 1, ll. 36-41). We therefore agree with the Examiner that the art would have suggested to a person of ordinary skill in the art using the porous silicon membranes taught by Northrup as the electrophoresis channels in Burns' DNA amplification and analysis device.

Appellant argues that the apparatus defined by claim 1 is a single-piece apparatus, while Burns "emphasizes the desirability of apparatus[es] that include two pieces that have been bonded together: a first piece with channels and other features for handling fluids; and a second piece upon which electronic components, including sensors, are fabricated" (Br. 18, citing Burns, col. 21-22). Thus, Appellant concludes, "neither Burns nor Northrup teaches or suggests at least one detector fabricated on the same substrate within which at least two matrices have been formed (Br. 19).

We do not find this argument persuasive. It is true that Burns teaches that "*[m]ost* of the devices of the invention are hybrid micromechanical devices (two substrates bonded together)" (col. 21, ll. 25-26, emphasis added). However, Burns also teaches devices in which the electrophoresis channels and detectors are fabricated on a single substrate:

> There are two basic techniques that may be used for construction of channel structures. The first technique uses a chemical or reactive ion etch to form open channels on selected areas of a substrate. . . . The open channels are sealed by bonding of a second substrate as a cap on top of the first one. . . .
>
> The second technique for the fabrication of channels relies on the sacrificial etch technique. . . . [T]his technique is referred to as surface micromachining. . . . In surface micromachined devices, the analytical instrumentation is built along with the channels on the same physical substrate.
>
> The devices by both the hybrid (bonded) and monolithic (surface machining) designs have been constructed.

(Burns, col. 26, ll. 5-44.) Burns also discloses "an electrophoresis unit that integrates a micromachined channel and an electronic DNA detector. The

channel is constructed using a sacrificial etch process on a single silicon wafer" (*id.* at col. 31, ll. 43-46).

In any case, the instant claims are directed to a device, not a method of making a device. In Burns' hybrid-device embodiment, after the two substrates are bonded together, they form a single substrate, upon which both the electrophoresis channels (porous regions) and detector are fabricated. Claim 1 thus reads on even Burns' hybrid-device embodiment.

7. OBVIOUSNESS BASED ON BURNS, NORTHRUP, AND DUBROW

Claim 21 stands rejected under 35 U.S.C. § 103 as obvious in view of Burns, Northrup, and Dubrow. Claim 21 requires the addition of a vacuum source to the device of claim 1. As discussed above, Burns and Northrup would have suggested the device of claim 1 to those of ordinary skill in the art. Burns also discloses that its device can include a "fluid-directing means system[ ] . . . that comprise[s] a gas source in fluid communication with the one or more transport channels and other components, such that application of differential gas pressure gradients result in the controlled flow of gases or liquids through the micromachined device" (Burns, col. 6, l. 66 to col. 7, l. 4). This disclosure would have suggested the inclusion of either a pump or vacuum source in Burns' device. In addition, as the Examiner stated, Dubrow teaches "a silica microscale electrophoresis device" (Dubrow, col. 2, ll. 34-35) comprising a vacuum source to drive a solution into a capillary channel (Answer 10, citing Dubrow, col. 7, ll. 1-10).

We agree with the Examiner that the cited references would have suggested the device of claim 21 to a person of ordinary skill in the art.

Appellant argues that "Claim 21 is allowable, among other reasons, for depending indirectly from claim 1, which is allowable" (Br. 19). Because we disagree with the premise of Appellant's argument – we conclude that claim 1 is not allowable – and Appellant does not provide any explanation of the "other reasons" supporting his conclusion that claim 21 is allowable, we affirm the Examiner's rejection.

SUMMARY

We reverse the anticipation rejection because Northrup does not disclose every limitation of the claimed apparatus. However, we affirm all of the obviousness rejections because the cited references would have made obvious the claimed apparatus to those of ordinary skill in the art.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

AFFIRMED

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